REMARKS

By this amendment, Applicants have amended claims 1 and 28 to eliminate the language deemed indefinite by the Examiner.

In view of the foregoing amendments to claims 1 and 28, it is submitted all the claims now in the application comply with the requirements of 35 U.S.C. §112, second paragraph.

Claims 1, 6, 14-18, 20 and 28 stand rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 4,966,799 to Lucca et al. as evidenced by U.S. Patent No. 4,131,664 to Flowers et al. Applicants traverse this rejection and request reconsideration thereof.

The present invention, as defined in independent claim 1, relates to an <u>ultra-light</u> sound insulator. See, page 1, lines 6-11 of Applicants' substitute specification. The ultra-light sound insulator 1 of the present invention includes a sound absorption layer 2 that is light in weight and has a thickness in a range of 1 to 50 mm, the thickness varying from one region to another in a range of 1-50 mm and a density in the range of 0.01 to 0.2 g/cm^3. See, Figures 3 and 4 and page 7, lines 15-29 and page 20, line 1 to page 21, line 4 of Applicants' substitute specification. An air-impermeable resonance layer 3 in the form of a <u>film having a thickness in a range of 10-200 μm</u> is bonded to the sound absorption layer 2 via an adhesive layer 4 and has an area-weight of not greater than 200 g/m^2. See, page 21, line 29 to page 22, line 10 of Applicants' substitute specification. Appellants choose the adhesion strength and adhesion area of the adhesive layer 4 to provide a particular resonance. That is, the adhesion strength of the adhesive layer 4 against the sound

absorption layer 2 and the air-impermeable resonance layer 3 is set in a range of 1-20 N/25 mm under conditions of an peel angle 180° and a peel width of 25 mm while an adhesion area of the adhesive layer 4 is 50-100% of a whole interface between the sound absorption layer 2 and the air-impermeable resonance layer 3. This provides a sound insulator 1 in which resonance due to a total mass of the air-impermeable resonance layer 3 and the sound absorption layer 2 occurs in addition to the membrane resonance of the air-impermeable resonance layer 2. In the ultra-light sound insulator 1 of the present invention, the sound absorption layer 2 is adapted to face a vehicle body panel while the air-impermeable resonance layer 3 is adapted to face a vehicle interior. See, Figures 3 and 4 and page 7, lines 15-29; page 22, lines 20-26; and page 23, line 15 to page 29, line 17 of Applicants' substitute specification. The ultra-light sound insulator presently claimed is not disclosed by or obvious over Lucca et al.

The Lucca et al. patent discloses a structural element that contains a first sound-absorbing and thermally insulating layer 21 and a second-insulating, dimensionally stable supporting layer 23. A porous or microporous decorative layer 22 can be applied to the outside of the first layer and a thermal formed carpet 24 can be applied to the outside of the supporting layer. A heat-sealable adhesive layer 27 can be placed between the two layers, the adhesive layer increasing the bond between the two layers. It is disclosed that, because of the dimensionally stable supporting layer, the structural element can be used as a sound screen without a holding frame or as a sound-insulating body work part without a supporting surface.

The structural element of Lucca et al. is different in both structure and concept from the ultra-light sound insulator of the present invention.

The sound insulator of the present invention is an <u>ultra-light</u> sound insulator. It is intended to be ultra-light and formed so that the sound absorption layer is adapted to face a vehicle body panel, while the air-permeable resonance layer is adapted to face a vehicle interior.

The ultra-light sound insulator of the present invention does not need to be dimensionally stable, does not need to itself form a structural element, and can have its thickness varied to adopt to the vehicle body panel to which it is applied. In contrast, because of the dimensionally stable supporting layer in Lucca et al., the structural element of Lucca et al. is intended to form a structural element that can be used without a holding frame or without a supporting surface.

Because of the differences in concept between the structural element of Lucca et al and the ultra-light sound insulator of the present invention, the structures of the structural element of the Lucca et al. and the ultra-light sound of insulator of the present invention are different.

One difference in structure between the ultra-light sound insulator of the present invention and the noise-reducing structural element of Lucca et al. is that the sound absorption layer in the ultra-light sound insulator of the present invention has a thickness in a range of 1 to 50 mm, the thickness varying from one region to another in a range of 1 to 50 mm.

On the other hand, Lucca teaches that an element which is to be used as a sound screen and needs to have little mechanical stability but good

sound absorption should possess a relatively thin supporting layer and a comparatively thick padding layer. In short, the sound screen of Lucca et al. should have a comparatively thick padding layer. That is, in the sound screen of Lucca et al., a high sound absorption rate cannot be assured when the thickness of the sound absorption layer is varied or reduced.

On the contrary, in the present invention, a high sound absorption rate is assured even when the thickness of the sound absorption layer is varied or reduced in a region according to the conditions, such as the needed shape of a product, due to other features in claim 1, such as the resonance layer and the adhesion conditions (adhesion strength and adhesion area) between the resonance layer and the absorption layer. Moreover, the sound absorption rate is assured in an even wider frequency domain and thus the sound absorption rate is improved as a whole by varying the thickness of the sound absorption layer, compared to a sound insulator that has a sound absorption layer without thickness variation.

Varying the thickness of the sound absorption layer is not disclosed in Lucca et al. Varying the thickness contradicts the requirement of a comparatively thick padding layer in Lucca et al. Accordingly, the advantageous effect of the present invention that sound absorption is improved as a whole in a wider frequency domain by varying the thickness of the sound absorption layer is not achieved by the sound screen of Lucca et al.

The resonance layer of the present invention is also different from the relatively thin supporting layer of Lucca. The resonance layer of the present invention is light in weight and has a low rigidity. This also contributes to the

above-described advantageous effect. On the contrary, the relatively thin supporting layer of Lucca et al. would be understood to have rather high rigidity since it is called "supporting layer." This is suggested throughout the claims and the specification of Lucca et al., for example, in the phrase "said second layer comprising rigid, impermeable, thermoformed, synthetic, and self-supporting material" in claim 1 of Lucca et al. In the present invention, resonance arises independently in a narrow area because the resonance layer has a low rigidity, and this leads to an improved sound absorption in a wider frequency domain when the thickness of the sound absorption layer is varied with location. On the contrary, the rigidity of the supporting layer of Lucca et al. prohibits resonance to arise independently in a narrow area, and thus prohibits the improvement in the sound absorption when the thickness of the padding layer is varied with location. The resonance layer of the present invention is thus different from the relatively thin supporting layer of Lucca that is rigid and that needs a comparatively thick padding layer to assure sound absorption. The resonance layer of the present invention would not have been obvious from the comparatively thin supporting layer of Lucca et al.

Moreover, the ultra-light sound insulator of the present invention uses an air-impermeable resonance layer that has a lower area weight than the supporting layer of Lucca et al.

The air-impermeable resonance layer of the present invention has an area-weight of not greater than 200 g/m^2 (= 0.2 Kg/m^2). On the other hand, the supporting layer of Lucca et al. has a much higher area-weight than the ultra-light sound insulator of the present invention as explained hereinafter.

The Lucca et al. patent discloses that the supporting layer has an density of 1.5 to 2.5 Kg/ℓ (= 1.5 to 2.5 Kg/dm^3 = 1500 to 2500 kg/m^3) (1dm = 1/10 m, $1dm^3 = 1/1000\ m^3$) and a thickness of 1 to 10 mm (see column 3, lines 41-44, column 4, lines 1 - 5, and claim 8 of Lucca et al.). The area-weight thereof is thus calculated to be 1.5 to 2.5 Kg/m^2 when the thickness is 1 mm, and 15 to 25 Kg/m^2 when the thickness is 10 mm. Accordingly the area-weight of the supporting layer is calculated to be 1.5 to 25 Kg/m^2.

In addition, the air-impermeable resonance-layer of the present invention is in the form of a film and the adhesion strength of the adhesive layer of the present invention is set in a range of 1 to 20 N/25 mm and the adhesion area of the adhesive layer is 50 to 100% of a whole interface between the sound absorption layer and the air-impermeable resonance layer.

On the other hand, in Lucca et al., the supporting layer (12, 23, 32) is "rigid or solid" and the adhesion strength of the adhesive layer is not disclosed. The supporting layer 12 in Fig. 1 is a solid sheet of a thermoformable plastic material (see column 2, lines 50 to 52). Supporting layer 23 in Fig. 2 is polypropylene containing a mineral filler (see column 2, line 68 to column 3, line 2). The supporting layer 32 in Fig. 3 is glass fiber-reinforced heat-setting material (see column 3, lines 13 to 15). Thus, a solid sheet of a thermoplastic or heat-setting material can be used for the supporting layer. In order to increase the mechanical strength of the supporting layer, a glass fiber-reinforced thermoplastic material can be used. Vulcanizable rubber is also suitable as a supporting layer (see column 4, lines

1 - 12). These materials are classified as heavy-weight sound insulating materials in conventional resonance theory.

In Lucca et al., adhesive strength and adhesive area of adhesive layers 15, 27, 35 against the supporting layers 12, 23, 32 are unclear. In general, an adhesive layer is not used or an adhesive layer having a small adhesive strength is used in an ultra-light sound insulator having a similar weight as the present invention. The lighter the sound insulator is, the simpler the adhesion method with less amount of adhesive material chosen in order to simplify the production process and to reduce the production cost. Thus an adhesion strength of less than 1 N/25mm and an adhesion area of not more than 20% are usually adopted for such an ultra-light sound insulator.

If the heavy-weight sound insulator disclosed in Lucca et al. is to be applied to a conventional ultra-light sound insulator, a person of ordinary skill in the art would have reason to adopt an insulator without an adhesive layer or adopt an adhesive layer having a minimum strength to prevent the supporting layer from dropping off the sound absorption layer.

On the other hand, the values of adhesion strength and adhesion area of the ultra-light sound insulator of the present invention are larger than values of a typical ultra-sound insulator and beyond the value range of the conventional conception. The minimum value of adhesion strength of 1 N/25 mm of the present invention is still larger than usually anticipated range values. Adhesion with the maximum value of 20 N/25 mm is a fairly strong adhesion and would not have been contemplated by one of ordinary skill in the art.

The resonance mechanism in Lucca et al. is also different from the resonance mechanism of the present invention.

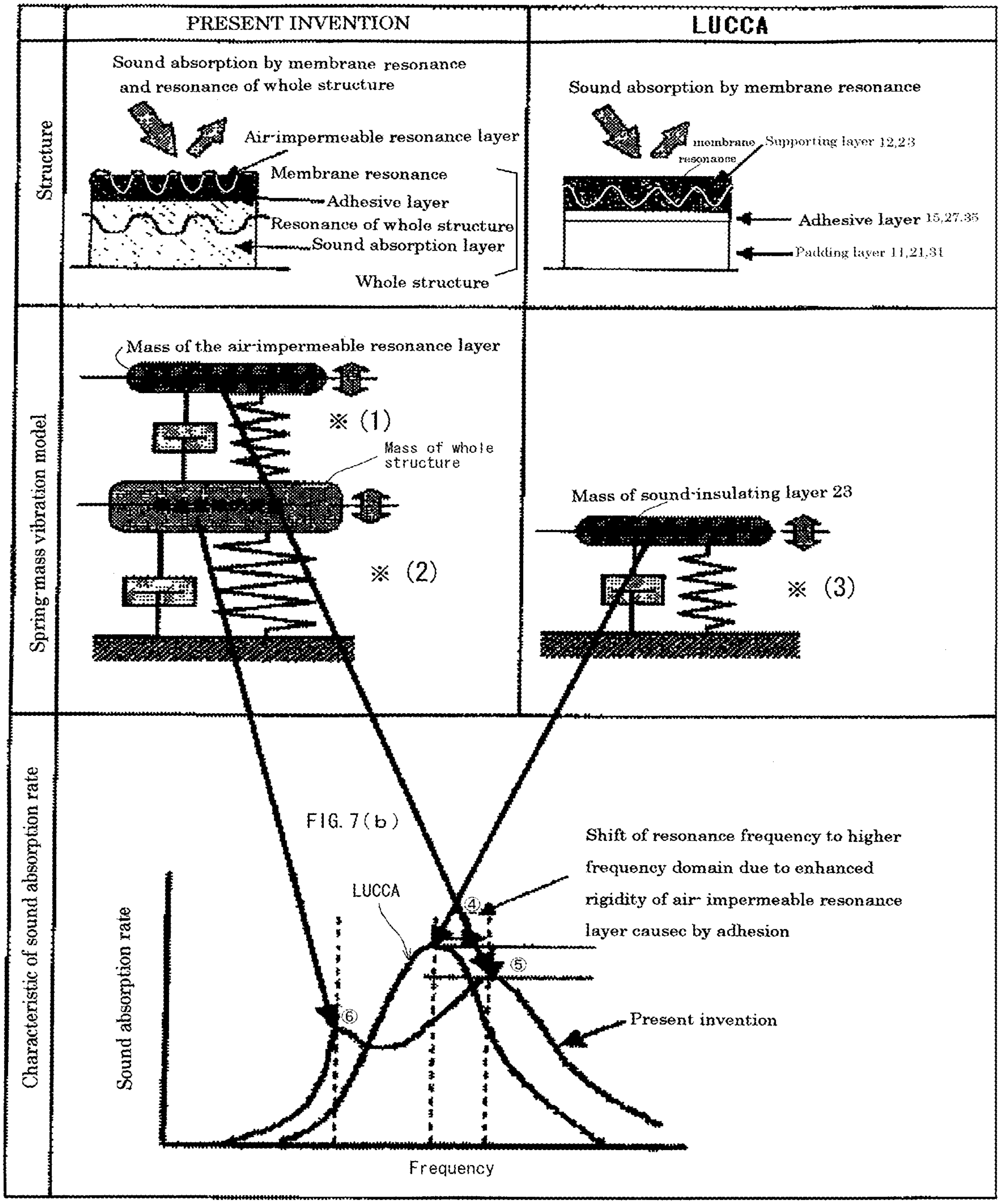
Considering the area-weight and materials of the supporting layer, the resonance mechanism of Lucca et al. is the same as the mechanism of the prior art listed in the specification of the present invention (shown in Figs. 27, 28, 29 of the present application), with both adopting a sound insulation theory.

To the contrary, the inventors of the present invention assume a spring-mass vibration model for the present invention.

In a spring-mass vibration model (A) membrane vibration of the air-impermeable resonance layer ascribed to the mass of the air-impermeable resonance layer alone and an air spring in the sound absorption layer, and (B) vibration of the whole structure (including the air-impermeable resonance layer and the sound absorption layer) ascribed to the total mass of the air-impermeable resonance layer and the sound absorption layer and the air spring in the sound absorption layer are combined,

A spring-mass vibration model is defined as a model in which a mass part fixed at an end of a spring is vibrated by the spring.

The following table of figures illustrates the differences between the present invention and Lucca et al.



(1) Spring-mass resonance (membrane resonance) ascribed to air-spring in sound absorption layer and mass of air-impermeable resonance layer
(2) Spring-mass resonance (non-membrane resonance) ascribed to air-spring in sound absorption layer and total mass of sound absorption layer and air-impermeable resonance layer
(3)Air spring constant of supporting layer 11,21,31 which corresponds to the air spring constant in sound absorption layer of the present invention

The spring-mass vibration model is explained from page 23, line 14 to page 27, line 17, particularly in page 25, line 12 to page 26, line 25 of Applicants' substitute specification, and is shown in Fig. 5(a) and (b) and Fig. 7(a) and (b) of the present application.

"Resonance" in the above table is defined as a phenomenon in forced vibration of a vibration system in which response against an external force such as displacement, velocity, and pressure is maximized at the vicinity of the natural frequency (resonance frequency) of the system as the frequency of the forced vibration is changed with the external force kept constant.

"External force" here corresponds to reflected noise in the vehicle interior described at page 5, lines 13-27 of Applicants' substitute specification. As described therein, the frequency domain of 800 to 1600 Hz is essential for the cleanness of conversation. It is also described that the prior art structure, such as that of Lucca et al., has insufficient sound absorption effects at the frequency of about 1000 Hz. Furthermore, as described at page 6, line 21 to page 7, line 5 of Applicants' substitute specification. The prior art structure has a poor sound absorption in a frequency domain of 315 to 800 Hz.

As shown above, the sound absorption layer is bonded to the air-impermeable resonance layer via an adhesive layer. By "regulating", or tuning the adhesive area and adhesive strength of the adhesive layer, resonance (B) ascribed to the total mass of the air-impermeable resonance layer and the sound absorption layer is induced, while resonance frequency of resonance (A) ascribed to the mass of the air-impermeable resonance layer is shifted to higher frequency domain.

Such a phenomenon does not occur by simply bonding a sound absorption layer to an air-impermeable resonance layer via an adhesive layer as in Lucca et al. The word "resonance" does not appear at all in the specification of Lucca et al. No resonance conditions, especially, no adhesive conditions are disclosed by Lucca et al. While the Examiner alleges that the adhesive layer of Lucca et al. has an adhesive area of 100 % based on the figures, the figures of Lucca et al. merely show the adhesive layer in a schematic manner. Adhesive conditions are not identified in the text at all. Accordingly, citing the figures as a basis for this rejection is unreasonable.

Transmission loss is enhanced by the resonance (A) and (B). Reduction of the transmission loss is decreased in the high frequency domain, where transmission loss is high (see (5) in Fig. 7(a)). Total reduction of the transmission loss is thus decreased considering the all frequency domains in Fig. 7(a). Although transmission loss is reduced in the low frequency domain (see (6) in Fig. 7(a)), the value of transmission loss itself is small there, so the reduction there does not greatly affect the total value.

The peak of resonance (B) appears in low frequency domain (see (6) in Fig. 7(b)). The sound absorption rate in the low frequency domain, where it was difficult to raise sound the absorption rate, can thus be enhanced.

The peak of resonance (A) in the high frequency domain is shifted to higher frequency domain compared to that of Lucca et al. (see (4) in Fig. 7(b)). The sound absorption rate is slightly reduced by this (see Fig. 7(b)(5)). However, the width of the wavy shape of the curve, namely the range of the

frequency, is widened as a whole, and the sound absorption rate is thus enhanced as a whole.

In the present invention, two peaks appear in the sound absorption rate curve and the characteristic of transmission loss is changed due to the resonances (A) and (B) described above.

Even if the resonance (A) can be expected in Lucca et al., the peak of Lucca et al. does not appear at optimum frequency. Moreover, Lucca et al. patent neither discloses nor suggests that resonance (B) is induced. The Lucca et al. patent also neither discloses nor suggests measurement data on the sound absorption rate and transmission loss.

The sound absorption rate and transmission loss have properties opposing each other. That is, the transmission loss is deteriorated when the sound absorption rate is ameliorated, while sound absorption rate is deteriorated when the transmission loss is ameliorated. In the field of ultra-light sound insulators, this was a tricky problem to be resolved.

The present invention is based on an idea which is clearly different from the conventional idea based on the conventional spring-mass theory (rigid body theory).

In the present invention, based on the observation that two peaks of different frequencies appear due to two kinds of resonances (A) and (B), the inventors tuned spring, mass, and adhesion strength and adhesion area of the adhesion layer, in order to obtain balanced optimum combinations of sound absorption rate and transmission loss.

This makes tuning of both the sound absorption rate and the transmission loss possible at any desired frequency band from low frequency domain to high frequency domain (see page 25, line 12 to page 26, line 24 of Applicants' substitute specification). Such is neither disclosed by nor obvious over Lucca et al.

For the foregoing reasons, the ultra-light sound insulator of the present invention is clearly not disclosed by Lucca et al. and would not have been obvious over Lucca et al.

The Examiner has cited the Flowers et al. patent as disclosing that bodywork outer layers have uneven contours. However, even assuming, *arguendo*, this to be true, sound insulation would be deteriorated in the insulator of Flower et al. in a similar way as in the insulator of Lucca et al. and other prior art when the thickness of the insulator is varied or reduced. Therefore, clearly the Flowers et al. patent does not remedy any of the other deficiencies noted above with respect to Lucca et al.

Therefore, the ultra-light sound insulator of the present invention is not disclosed by Lucca et al. and would not have been obvious over Lucca et al., even "as evidenced by Flowers et al."

In view of the foregoing amendments and remarks, favorable reconsideration and allowance of all the claims now in the application are requested.

Please charge any shortage in the fees due in connection with the filing

of this paper, including extension of time fees, to the deposit account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (Case: 1089.45436X00), and please credit any excess fees to such deposit account.

Respectfully submitted,

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